Slope Stability

Guadalupe River Channel

Santa Clara County Flood Control and Water Conservation District

MOORE & TABER · Engineers · Geologists

TA
710.3
G8.S6
1959

1.4.170

TA710.3G8S6 1959

Slope Stability

Guadalupe River Channel

Santa Clara County Flood Control
and
Water Conservation District

July 1959

MOORE and TABER
Engineers - Geologists

Guadalupe River Channel
Santa Clara County Flood Control and
Water Conservation District

Slope Stability

Studies of channel slope stability have been made at indicated locations in accordance with the agreement between the District and Moore & Taber for the purpose of determining suitable unlined side slopes for proposed channel improvements.

Field Work:

Field work for this project included eleven rotary sampled borings carried to depths of ten feet or more below projected channel grade. Samples were taken in the borings by means of a two-inch O.D. standard penetration sampler and a 2½-inch thin wall sampler. Where required to advance the sampler, a hammer delivering 350 ft. lbs. per blow was used. In addition to the borings, two cone penetrometers were driven at Locations 4 and 5 to determine variations in soil consistency. Samples were cut from the banks at several locations for supplemental tests and measurements were made of existing channel slopes. Boring locations were marked in the field and elevations referenced to the bench marks shown on the "Log of Test Borings" drawings.

Testing:

The testing employed for these studies was of two types. In-place measurements of strength were made by means of the "standard penetration" test, in which penetration resistance of the sampler is correlated to soil properties, the cone penetrometers and vane shear tests. Laboratory testing consisted of unit weight and moisture determinations, unconfined compression tests, direct shear tests and tri-axial shear tests. Classification of the soils was by inspection of the samples and continuous examination of drill cutting returns.

Summaries of direct shear testing and results of tri-axial shear tests are shown on accompanying sheets. The results of other tests are shown on the "Log of Test Borings" drawings. Conditions for the tri-axial shear tests are noted on the sheets. Direct shear tests were performed on undrained samples consolidated at light unit normal loads and sheared at a constant rate of .042 inches per minute. Other testing was performed in accordance with standard laboratory procedures.

Earth Materials:

The soils encountered at Locations 2 through 5 consist of very weak estuarine deposits of silt, clayey silt and sandy silt locally containing abundant organic material and typically including thin sand layers. At Location 1, a weak alluvial sequence of silt, sand and clay was encountered. At all other locations, the soils are also characteristically alluvial but generally of greater strength and containing more coarse granular materials. Two exceptions to the generally higher strength were encountered; at Locations 7 and 8 weak silt was encountered at depths of 5 to 10 feet below projected channel grade. Details of the distribution of the earth materials are shown on the accompanying "Log of Test Borings" drawing.

Analysis:

Analysis of all slopes was made by at least two independent methods. The moment method was used to make initial slope determinations. This method assumes both homogenous slopes and materials. Since the materials at these sites are non-homogenous in varying degree, a number of trials at each location was used to determine the effect of the soil variables. Slopes determined by the moment method were checked by the method of slices which is particularly suitable for evaluation of non-homogenous materials directly. Empirical methods were utilized to assure rationality of final slopes.

An instantaneous drawdown from sustained bank-full to channel bottom condition was assumed for the analyses. All materials are considered as saturated, except for the coarsest granular materials which were assumed partially drained. Height of slope was taken to be 15 feet below bank elevation at Locations 1-5 and approximately 5 feet below existing channel grade at Locations 6-11. No levee surcharge or other surcharge loads were considered.

Factors of safety for the slopes range from 1.1 to 1.8. These values appear suitable because analyses are based upon low average strength and because of the very severe drawdown condition postulated.

Slope Recommendations:

Location No. 5

Slopes not exceeding 4:1 are recommended. Since the soils at this site display a ratio of undisturbed strength to disturbed strength as low as 1:10 as indicated by vane shear, embankments of thoroughly disturbed material in this reach may not be stable at slopes greater than 8:1. Placement of channel spoil adjacent to slopes or as levee material may seriously impair stability of the slopes.

Locations No. 4, 3 and 2

Slopes not exceeding 3:1 are recommended. Embankments of thoroughly disturbed material may not be stable at slopes in excess of 4:1. Levee sections may affect stability of the slopes.

Location No. 1

Slopes not exceeding 1½:1 are recommended.

Location No. 6

Slopes not exceeding 1:1 are recommended. Minor variations of slope height will have little effect on stability which is largely dependent upon the strength of uppermost 20 feet of soil.

Location No. 7

Slopes not exceeding 1½:1 are recommended. The occurrence of weak silt at or slightly below final channel grade elevation has a marked effect upon the stability of this slope.

OFFICE COPY
[illegible] CLAPA
DO NOT REMOVE FROM [illegible]

Location No.8

Slopes not exceeding 1:1 are recommended. The weak silt bed apparent at Location No. 7 also occurs at this site but at a lower elevation, thus here having little effect on slope stability.

Locations No. 9, 10 & 11

Slopes not exceeding 3/4:1 are recommended.

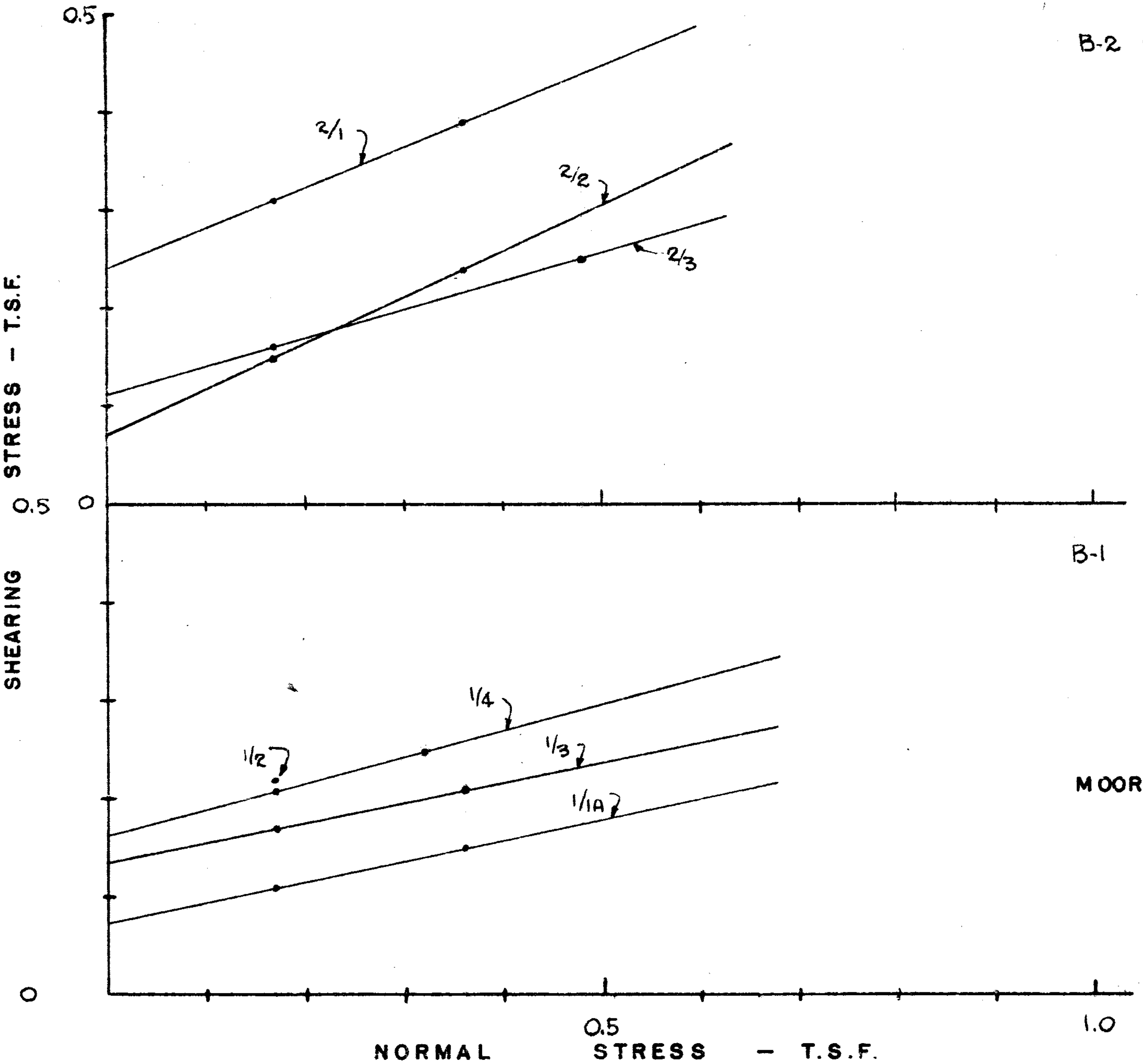
B earing Value of Soils:

Soil bearing at approximately 5 feet below ultimate grade at road crossings at Locations 1 and 5 is approximatly 1000 p.sf. and less than 250 p.s.f. respectively. Pile support should be utilized for addition to or reconstruction of these structures. Soil bearing at other locations of this study can be readily supplied from the data which has been obtained.

Moore & Taber

H. R. Taber
H. R. Taber
Engineer - Geologist
C. E. 9165

July 30, 1959

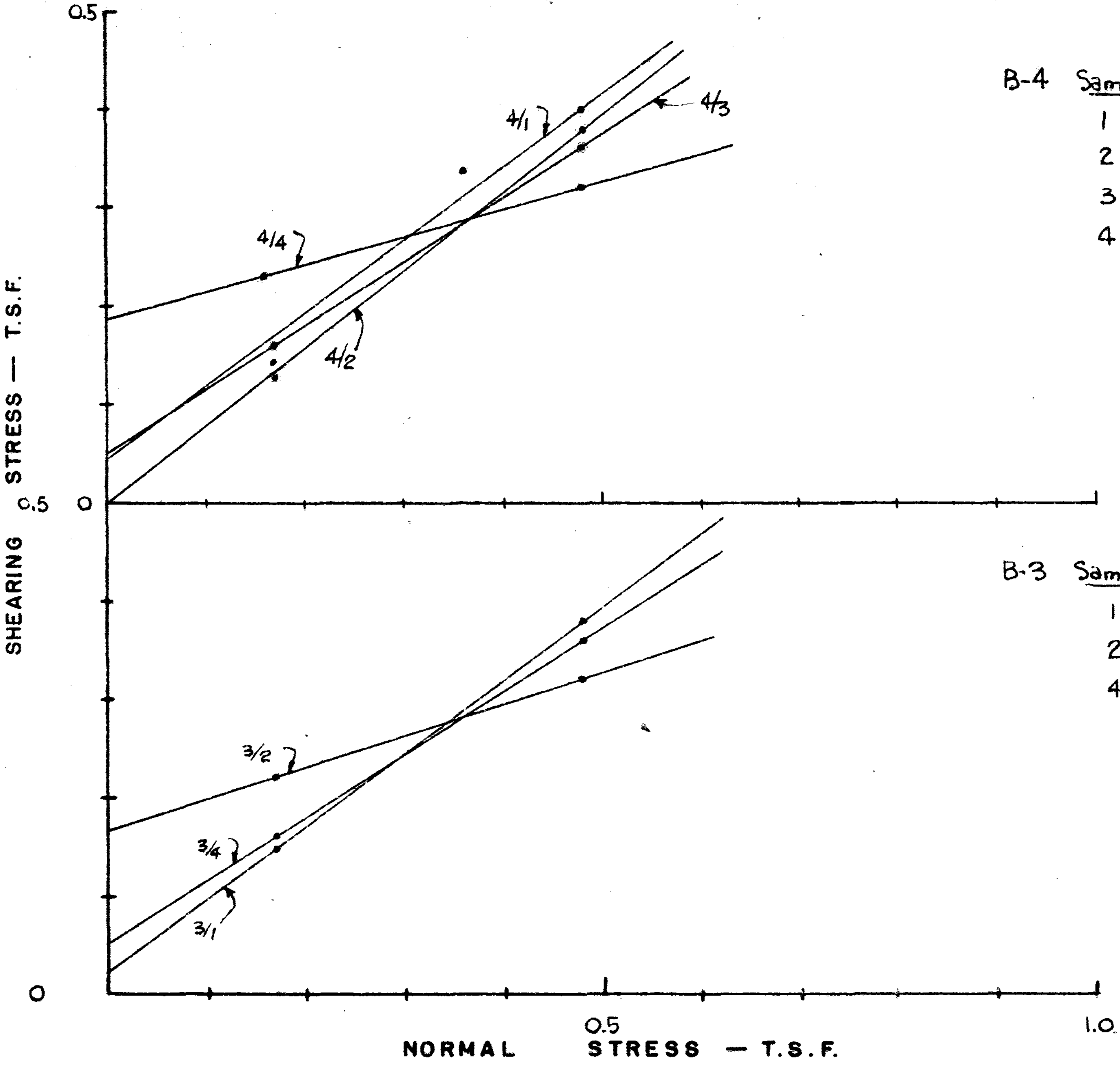


B-2 Sample	c (t.s.f.)	ϕ(°)
1	.24	23
2	.07	25
3	.11	16

B-1 Sample	c (t.s.f.)	ϕ(°)
1A	.07	12
3	.14	12
4	.16	15

MOORE & TABER - 3916

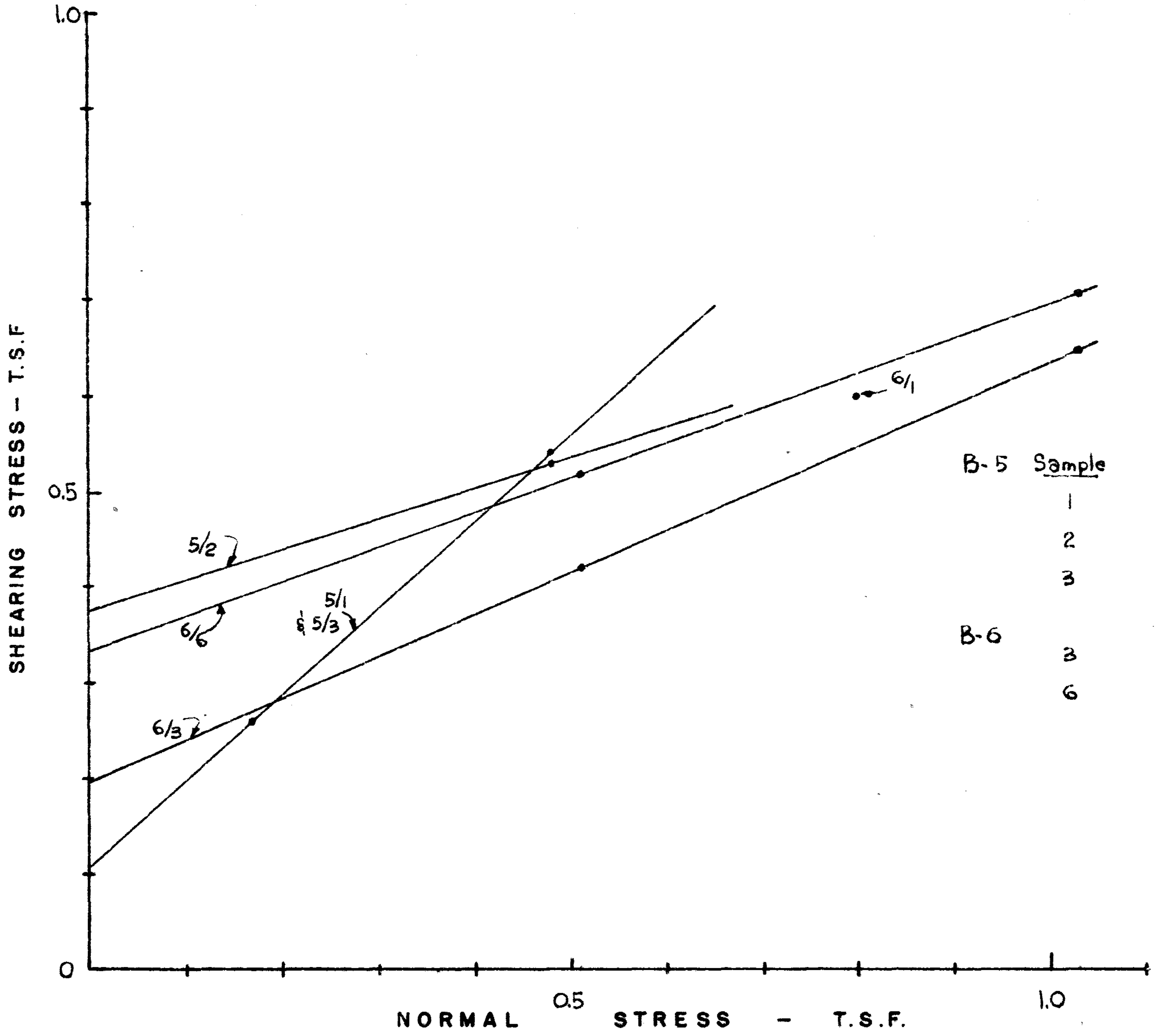
SUMMARY OF DIRECT SHEAR - SHEET 1



B-4	Sample	c(t.s.f.)	φ(°)
	1	.06	36
	2	0	38
	3	.04	37
	4	.19	16

B-3	Sample	c(t.s.f.)	φ(°)
	1	.02	37
	2	.17	18
	4	.05	33

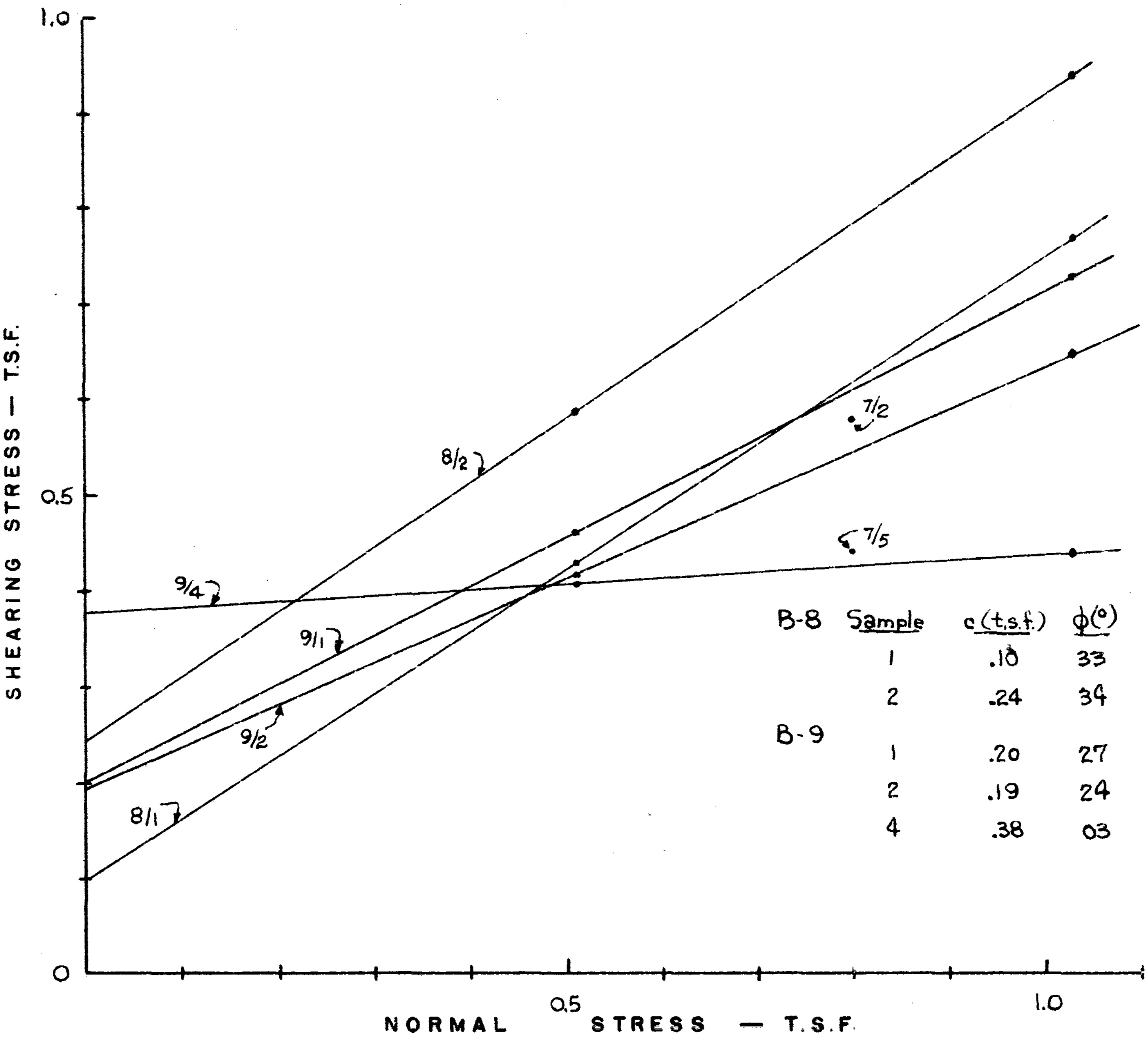
SUMMARY OF DIRECT SHEAR - SHEET 2



B-5	Sample	c (t.s.f.)	φ (°)
	1	.11	42
	2	.38	18
	3	.11	42
B-6			
	3	.20	24
	6	.33	20

MOORE & TABER
3916

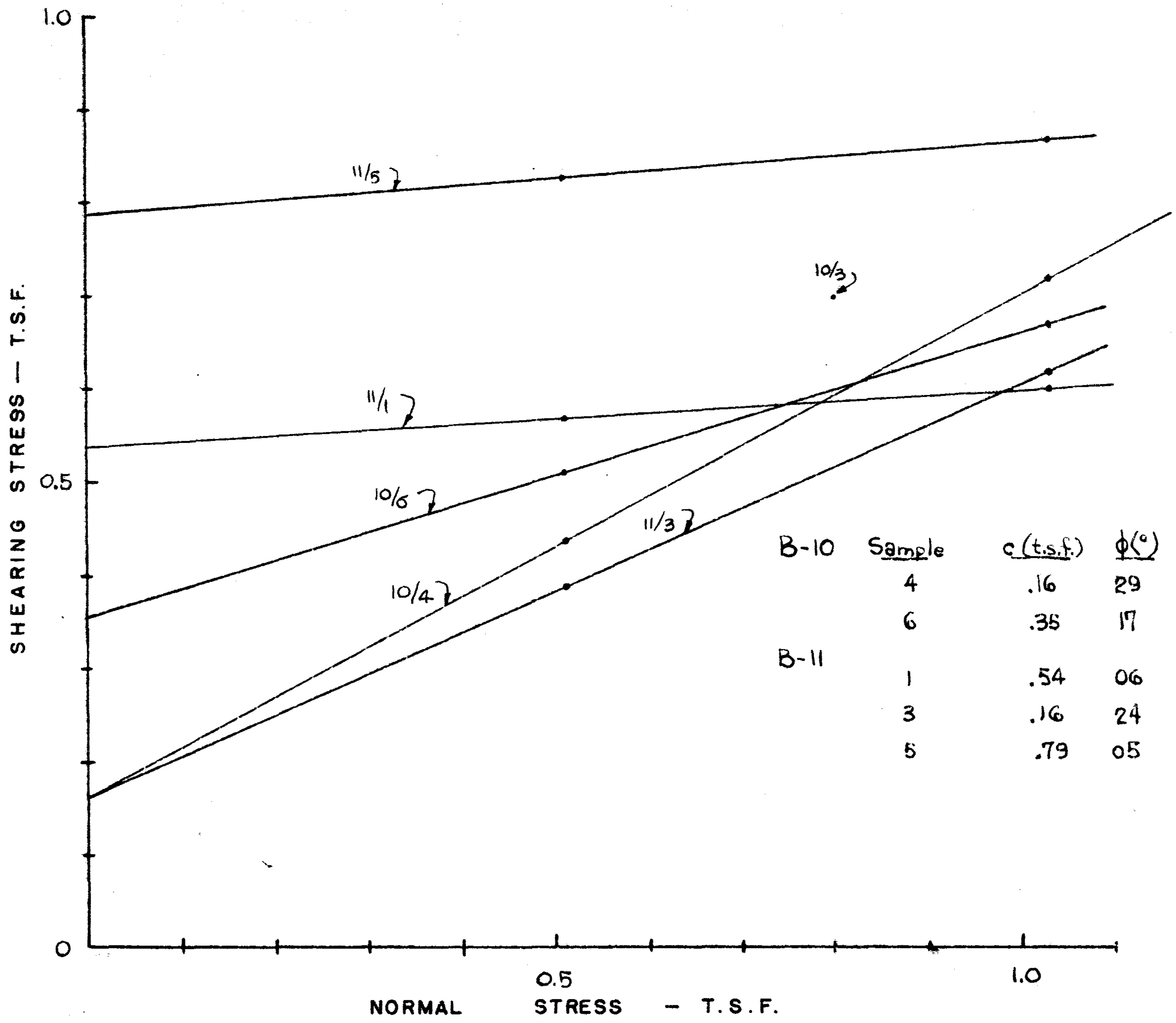
SUMMARY OF DIRECT SHEAR — SHEET 3



	Sample	c (t.s.f.)	φ(°)
B-8	1	.10	33
	2	.24	34
B-9	1	.20	27
	2	.19	24
	4	.38	03

SUMMARY OF DIRECT SHEAR — SHEET 4

MOORE & TABER 3916

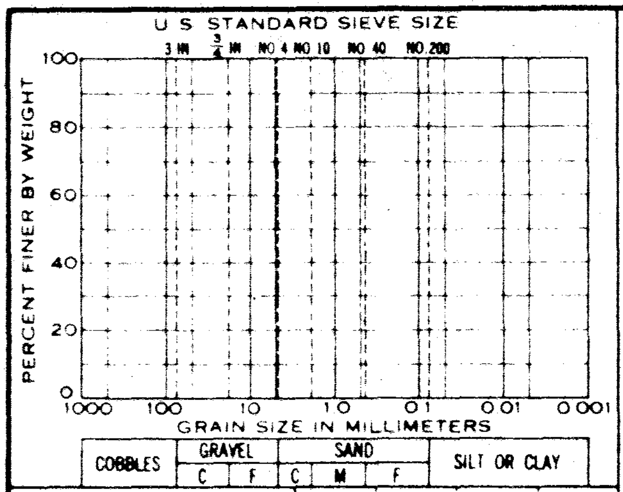


B-10	Sample	c (t.s.f.)	φ(°)
	4	.16	29
	6	.35	17
B-11			
	1	.54	06
	3	.16	24
	5	.79	05

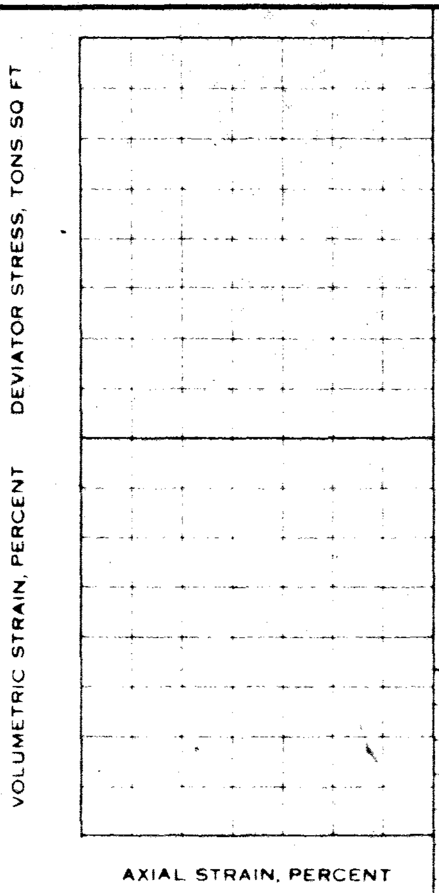
SUMMARY OF DIRECT SHEAR — SHEET 5

MOORE & TABER 3916

DO NOT REMOVE FROM OFFICE
COPY



		A	B	C
	Test No.			
INITIAL	Water Content, W_o %	30.2		
	Dry Density Lbs/Cu Ft	74.0		
	Void Ratio, e_o	1.25		
	Saturation, S_o %	67		
BEFORE TEST	W.C. after Saturation, W_s %			
	Saturation, S %			
	Consol Pressure (TSF)			
	W.C. after Consol, W_c %			
	Void Ratio after Consol e_c			
AT FAILURE	Maj Prin Stress, σ_I (TSF)	1.56	3.20	5.04
	Min Prin Stress, σ_{III} (TSF)	0.72	1.44	2.16
	Pore Pressure, u (TSF)			29.4
	Water Content, W_F %			
	Void Ratio, e_F			
Speciman Dia INCHES		1.31		
Initial Height INCHES		3.25		
Test Time to Failure Min		5.2	6.9	6.7



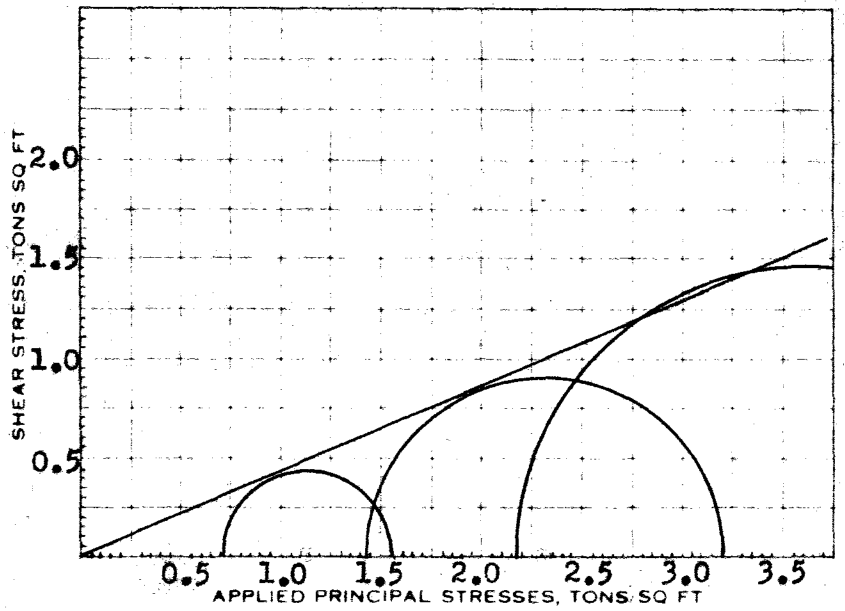
Type of Test
Constant **Pressure**
Strain Control (.042"/min.)
Consolidated, **Not** Drained

Type of Specimen **cylindrical**

ø = 22°	Tan ø = .44	c = 0 TSF

Classification

LL	G 2.68 E
PL	D

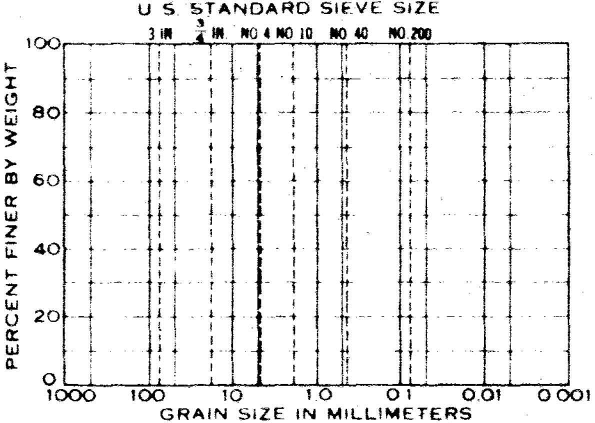


Remarks:

MOORE and TABER

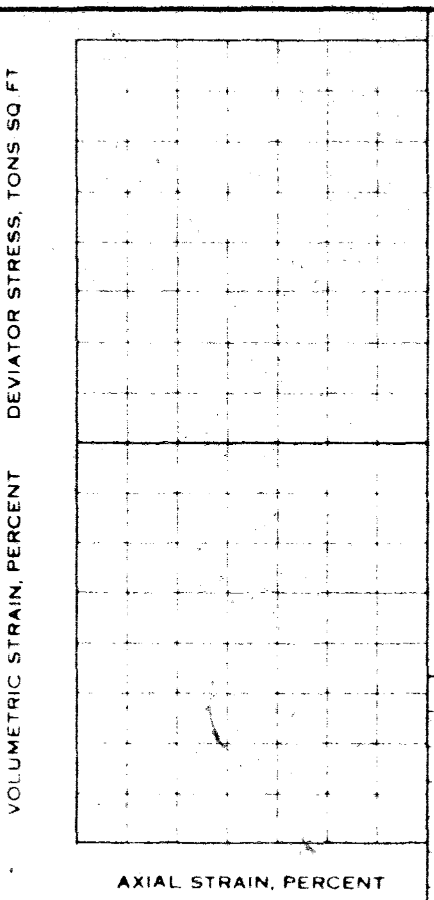
Project GUADALUPE	Nº 3916
Client S.C.C.F.C. & W.C.D.	
Boring No. 3	Sample No.
Elev ~~or Depth~~ 43	Date

TRIAXIAL COMPRESSION TEST REPORT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	C	F	C	M	F	

Test No.		A	B	C
INITIAL	Water Content, W_o %	20.7		
	Dry Density Lbs/Cu Ft	84.6		
	Void Ratio, e_o	0.96		
	Saturation, S_o %	59		
BEFORE TEST	W.C. after Saturation, W_s %			
	Saturation, S %			
	Consol Pressure (TSF)	1.01	1.89	2.88
	W.C. after Consol, W_c %			
	Void Ratio after Consol e_c			
AT FAILURE	Maj Prin Stress, σ_I (TSF)	3.36	4.61	6.12
	Min Prin Stress, σ_{III} (TSF)	1.01	1.89	2.88
	Pore Pressure, u (TSF)			
	Water Content, W_F %			33.0
	Void Ratio, e_F			
Speciman Dia. INCHES		1.31		
Initial Height INCHES		3.25		
Test Time to Failure Min.		4.7	3.6	5.5



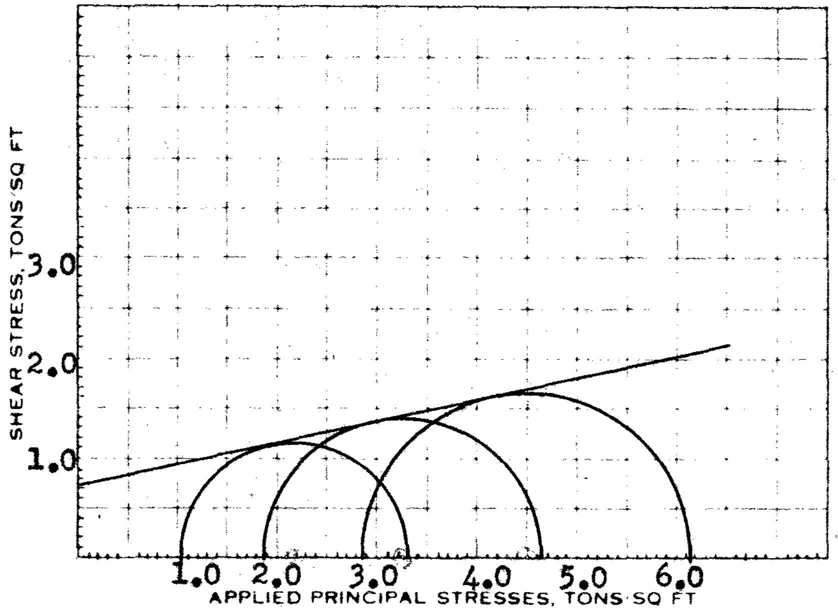
Type of Test
Constant **Pressure**
Strain Control(.042"/min.)
Consolidated, **Not** Drained

Type of Specimen **Cylindrical**

Ø = 12°	Tan Ø = .213	c-0.75 TSF

Classification Lt Brn clayey silt

LL	G 2.65 E
PL	D_{10}



Remarks:

MOORE and TABER

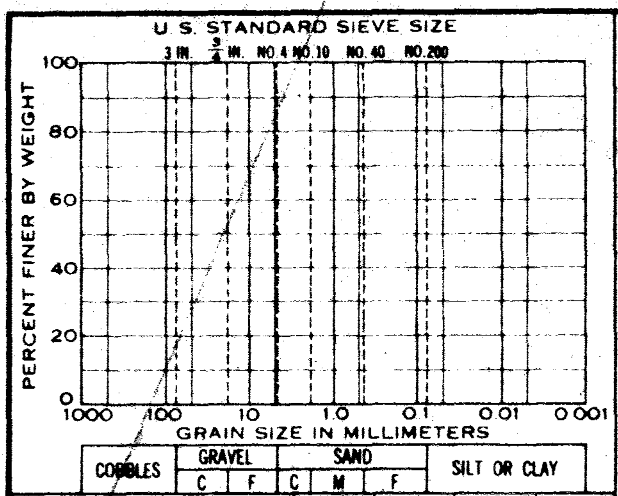
Project GUADALUPE №. 3916

Client S.C.C.F.C. & W.C.D.

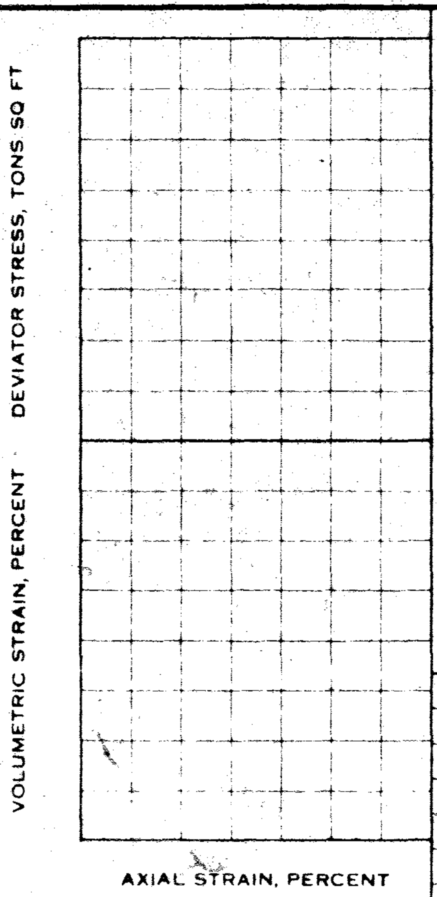
Boring No. 6 Sample No.

Elev or ~~Depth~~ 85 Date

TRIAXIAL COMPRESSION TEST REPORT



		A	D		
	Test No.	A	D		
INITIAL	Water Content, W_o %	21.5	22.6		
	Dry Density Lbs/Cu Ft	82.8	83.0		
	Void Ratio, e_o	1.00	0.99		
	Saturation, S_o %	57	60		
BEFORE TEST	W.C. after Saturation, W_s %				
	Saturation, S %				
	Consol Pressure (TSF)	1.01	2.88		
	W.C. after Consol, W_c %				
	Voic Ratio after Consol e_c				
AT FAILURE	Maj Prin Stress, σ_I (TSF)	3.36	7.88		
	Min Prin Stress, σ_{III} (TSF)	1.01	2.88		
	Pore Pressure, u (TSF)				
	Water Content, W_F %				
	Void Ratio, e_F				
	Speciman Dia. INCHES	1.31	1.31		
	Initial Height INCHES	3.25	3.25		
	Test Time to Failure Min.	4.9	7.1		



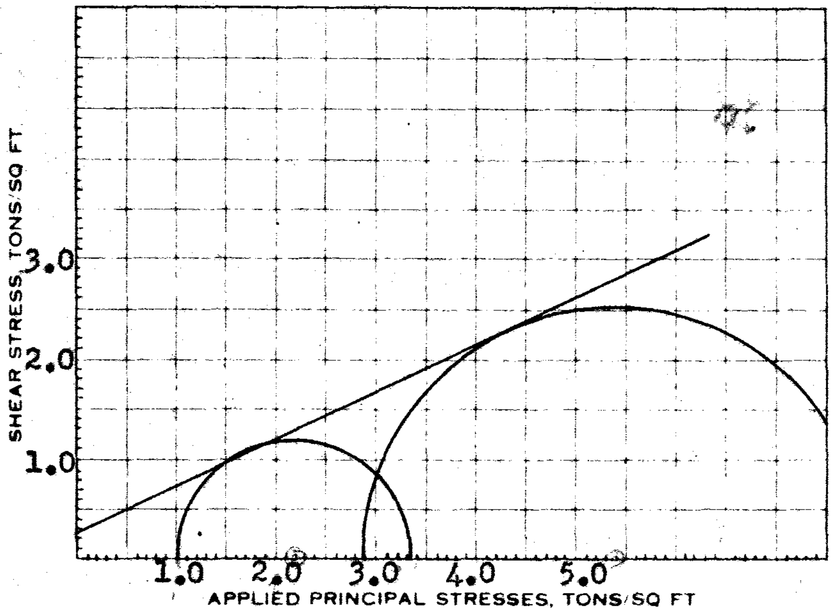
Type of Test
Constant **Pressure**
Strain Control (.042 in/min)
Consolidated, Drained

Type of Specimen cylindrical

ø = 25°	Tan ø = .466	c - 0.25 TSF

Classification Lt. brn clayey silt

LL	G 2.65 E
PL	D_{10}



Remarks:

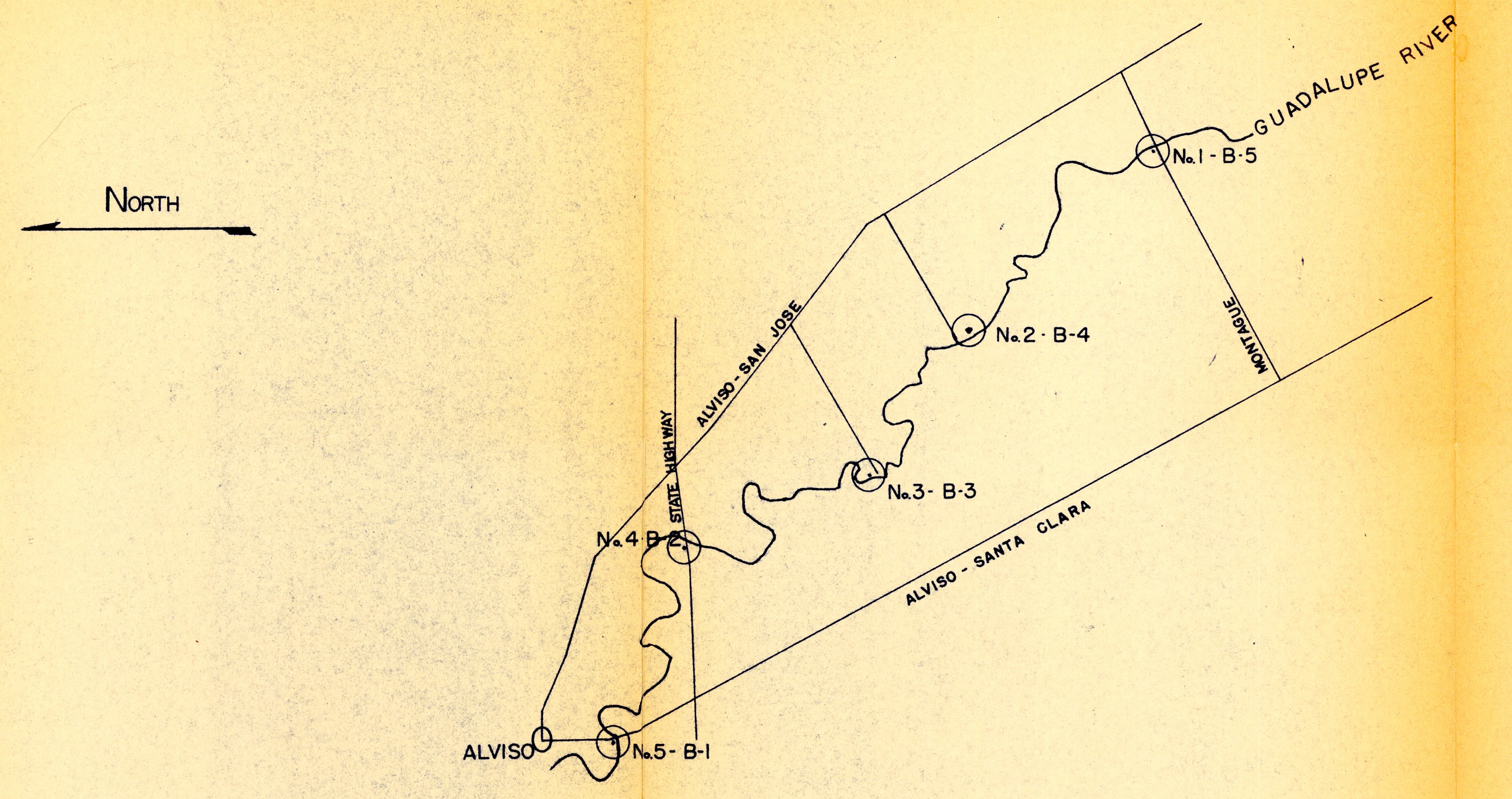
MOORE and TABER

Project GUADALUPE Nº 3916

Client S.C.C.F.C. & W.C.D.

Boring No. 6	Sample No.
Elev or ~~Depth~~ 85	Date

TRIAXIAL COMPRESSION TEST REPORT



NOTE

B-1 C. of E. bronze disc S.E. wingwall of existing bridge. El. 50.00 (assumed).
B-2 T. B. M. Top of steel manhole cover at D640+05 El. 50.00 (assumed).
B-3 T.B.M. Deck of existing timber farm bridge. El. 50.00 (assumed).
B-4 T.B.M. Deck of state highway bridge at stream centerline. El. 50.00 (assumed).
B-5 U.S.C.& G.S. disc in S.W. wingwall existing bridge El. 50.00 (assumed).

60
50
40
30
20
10
B-1
El. 51.1
3.0"
Fill and rocky debris.
Very loose gray and brown to dark gray silty sand & silt.
G.W.S. El. 45.6 6-12-59
Soft and loose interbedded gray silty clay and clayey sand and gravel.
Very soft light gray clayey silt with organic material- occasional layers of clayey fine sand.
S 98 27 2.5" 5
S 47 88 333 VS 2.5" 2
S 49 87 2.5" 2
0.4 51 83 1.4" <2
1.4" 2
6-9-59
B-1A
El. 50.5
6-10-59
B. P. F.
10
20
30
B-2
El. 40.0
3.0"
G.W.S. El. 36.9 6-12-59
S 69 22 750 VS 2.5" 4
Very soft brown and gray clayey silt and very fine sandy clayey silt- with abundant organic material.
S 78 40 600 VS 2.5" 2
Very soft blue gray interbedded clayey silt, silt & very fine sandy clayey silt- occasional thin stringers of clayey fine sand.
S 50 94 2.5" 2
0.4 50 87 1.4" <2
0.6 59 69 1.4" <2
Slightly compact blue gray fine to coarse sand and fine gravel.
125 14 1.4" 4 14
6-10-59
B-2A
El. 40.0
6-10-59
B. P. F.
B-3
El. 45.77
3.0"
Very loose brown silt with thin beds of very fine to fine sand.
S 82 33 515 VS 2.5" 2
G.W.S. El. 37.8 6-12-59
T S 72 41 2.5" 3
0.6 89 33 1.4" 2
Very loose dark gray silt with beds of sandy silt- some organic material.
S 59 62 667 VS 2.5" 3
Very loose and very soft dark blue gray interbedded peaty sand, clayey sand and clayey silt with abundant organic material.
0.5 65 59 1.4" 3
0.5 87 34 1.4" 3
6-10-59
B-4
El. 48.20
3.0"
Very loose brown interbedded silt and fine to medium sand.
S 90 26 2.5" 4
G.W.S. El. 39.0 6-12-59
S 84 33 2.5" 2
Very loose gray silt and sandy silt with some silty sand & abundant organic material.
S 80 38 533 VS 2.5" 3
Very loose and very soft dark gray silt and clayey silt- with thin layers of fine to medium sand and abundant organic material.
S 66 43 2.5" 4
0.5 65 56 1.4" 3
1.4" 3
Very loose blue gray silt with scattered organic material.
Stiff yellow brown silt and clayey silt.
6-11-59
B-5
El. 44.1
3.0"
Loose to slightly compact brown sandy silt and silty fine sand.
S 100 18 2.5" 16
G.W.S. El. 35.9 6-12-59
S 98 23 2.5" 9
Soft brown and gray mottled clayey silt and silty clay.
Slightly compact yellow brown clayey fine sand with layers of sandy clay.
S 107 20 2.5" 13
1.4" 8
Loose yellow brown interbedded silt, fine sand and clayey fine sand with some thin beds of clayey clayey silt.
1.5 77 52 1.4" 7
6-12-59

SAMPLE 1/1A EL. 45 ẟ=53 , M=76 Ⓢ
VANE SHEAR AT " 167 PSF
" " " EL. 43 150 "

LEGEND OF EARTH MATERIALS

SIZE CLASSIFICATION

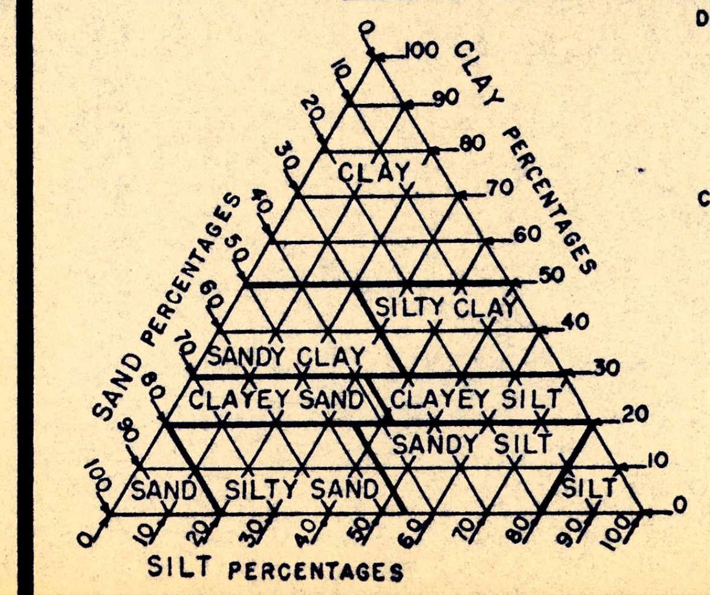


Diagram showing the basis of grainsize distribution used in determination of class names. Size classification is based on the Wentworth grade scale in field classification or the A.S.T.M. grade scale in the laboratory sieve analysis.

Classification of earth material shown on this sheet is based on field inspection and should not be construed to imply mechanical analysis unless so stated.

MATERIAL SYMBOLS

- ▨ Gravel
- ▨ Sand
- ▨ Silt
- ▨ Clay
- ▨ Sandy clay or clayey sand
- ▨ Sandy silt or silty sand
- ▨ Silty clay or clayey silt
- ▨ Peat or organic matter
- ▨ Fill material
- ▨ Shale
- ▨ Sandstone
- ▨ Limestone
- ■ Metamorphic rock
- ▩ Igneous rock

CONSISTENCY CLASSIFICATION

According to the Standard Penetration Test.

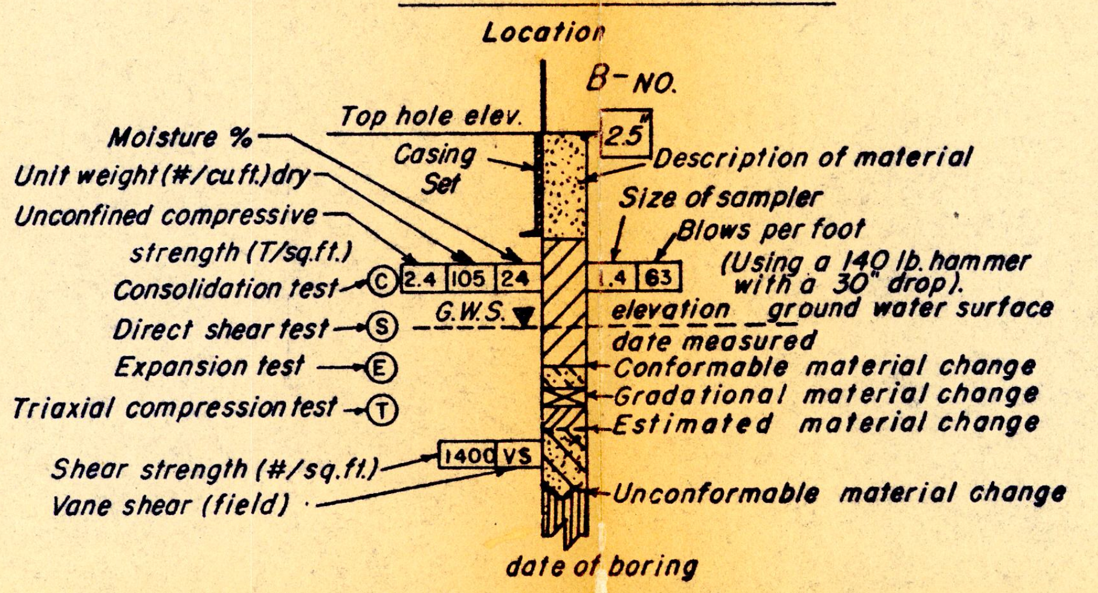
No. of blows	Granular	Cohesive
0-5	very loose	very soft
6-10	loose	soft
11-20	slightly compact	stiff
21-35	compact	very stiff
36-70	dense	hard
70+	very dense	very hard

VERNLITE CLEARPRINT 1000H

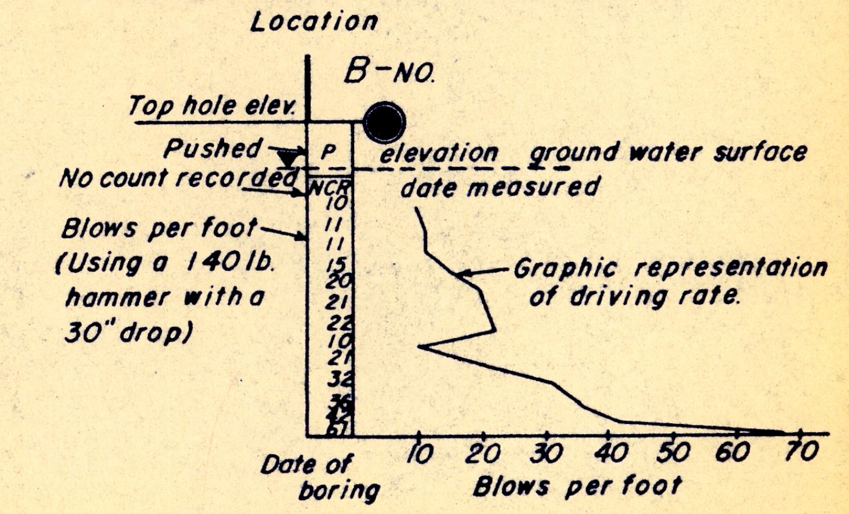
LEGEND OF BORING OPERATIONS

- ● Plan of any boring
- Ⓢ Flush penetrometer
- ◉ 2.5" Cone penetrometer
- ☐ Rotary boring
- ☐ Auger boring
- ☐ Sample boring
- ☐ Jet boring
- ◇ Diamond core boring
- ☐ Test pit

ROTARY BORING


Location
B-NO.
Top hole elev.
Casing Set
2.5"
Description of material
Moisture %
Unit weight (#/cu.ft.) dry
Unconfined compressive strength (T/sq.ft.)
Consolidation test Ⓒ
2.4 105 24
Size of sampler
Blows per foot
(Using a 140 lb. hammer with a 30" drop).
1.4 63
G.W.S.
elevation ground water surface
date measured
Direct shear test Ⓢ
Expansion test Ⓔ
Triaxial compression test Ⓣ
Conformable material change
Gradational material change
Estimated material change
Shear strength (#/sq.ft.)
Vane shear (field)
1400 VS
Unconformable material change
date of boring

PENETRATION TEST


Location
B-NO.
Top hole elev.
Pushed
No count recorded
P
NCR
elevation ground water surface
date measured
Blows per foot (Using a 140 lb. hammer with a 30" drop)
Graphic representation of driving rate.
Date of boring
10 20 30 40 50 60 70
Blows per foot

MOORE and TABER
Engineers —— Geologists

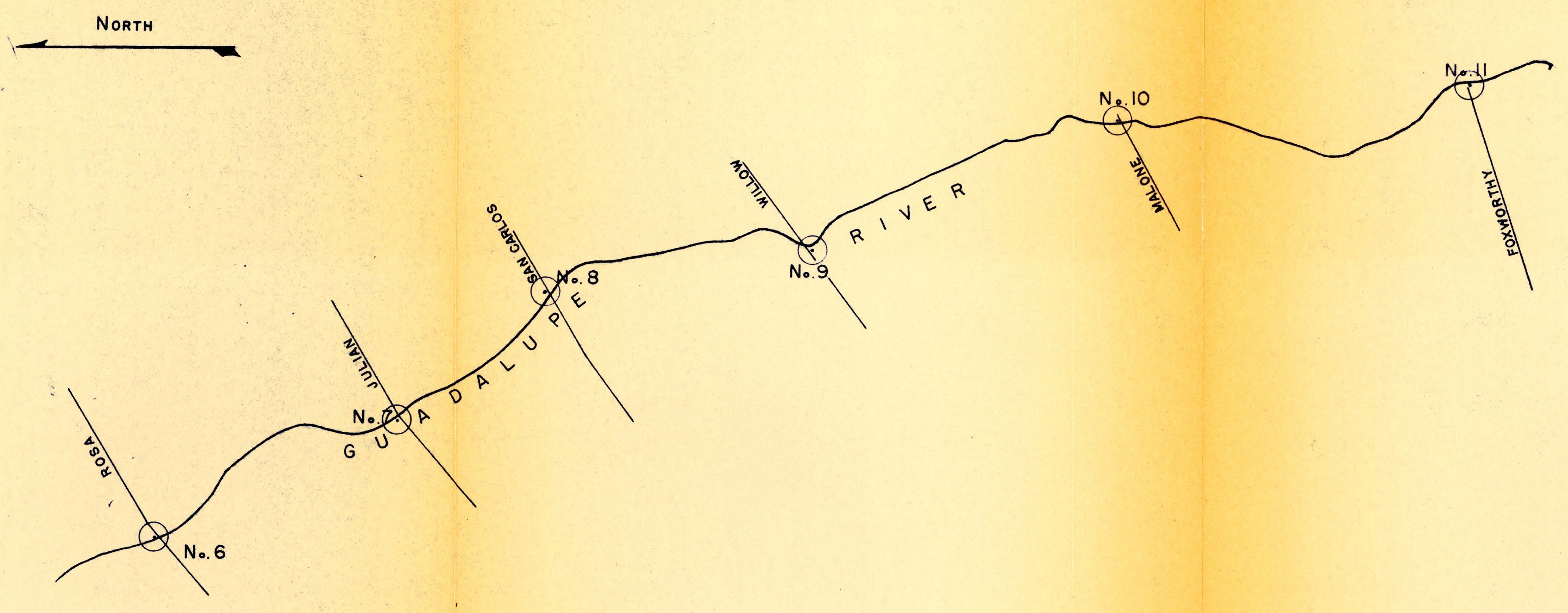
Job No. 3916F-1 APPROVED H.R. Taber 7-20-59
LICENSED CIVIL ENGINEER No. 9165

SANTA CLARA COUNTY FLOOD CONTROL
AND WATER CONSERVATION DISTRICT

GUADALUPE RIVER CHANNEL

LOG OF TEST BORINGS

Scale	Date	File	Drawing



NOTE

B-6 T.B.M. Centerline Rosa St. at East Bridge abutment. El. 100.00 (assumed)

B-7 U.S.C.& G.S. bronze disc at S.W. corner existing bridge. El. 100.00 (assumed)

B-8 T.B.M. Deck of existing bridge at stream centerline. El. 100.00 (assumed).

B-9 T.B.M. Deck of existing bridge at stream centerline El. 100.00 (assumed).

B-10 Mark chiselled in S.E. curb existing bridge. El. 100.00 (assumed).

B-11 T.B.M. Intersection centerlines Foxworthy & Almaden. El. 100.00 (assumed).

110
100
90
80
70
60
B-6
El. 100.00
3.0"
Soft gray and brown sandy, gravelly clay.
S 107 19 2.5" 5
1.0 92 28 1.4" 2
Very soft to soft gray and brown mottled silty and sandy clay with some scattered fine gravel.
T S 91 29 2.5" 7
1.4" 15
1.4" 14
Stiff gray and brown gravelly and silty clay.
G.W.S. El. 75.2 1-16-59
S 76 45
2.5" 15
1.4 115 15 1.4" 19
Stiff brown silty, sandy and gravelly clay with beds of clayey gravel.
6-12,16-59
B-7
El. 98.60
3.0"
Silty sand, gravel and rubble-fill.
2.5" 20
S 81 14 2.5" 8
Loose gray and brown silty fine to medium sand with clayey and gravelly layers.
107 18
G.W.S. El. 82.6 6-16-59
1.4" 10
Slightly compact gray brown silty sand & fine to medium gravel.
2.5" 18
S 103 25 2.5" 14
Slightly compact olive green silt with thin layers of med. sand.
Loose blue gray and blue green silt with beds of fine sandy silt.
1.1 97 27 1.4" 6
6-16-59
B-8
El. 96.80
3.0"
Compact brown and gray silt with beds of clayey silt and very fine sand.
S 104 18 2.5" 20
Slightly compact brown clayey and silty fine sand with some fine to medium gravel.
S 109 18 2.5" 18
120 11 1.4" 27
G.W.S. El. 79.2 6-17-59
Compact gray and brown silty and clayey sand and fine to medium gravel.
1.4" 24
Slightly compact gray & olive green silt with fine sand beds.
1.4" 14/6
Soft dark gray silt.
6-17-59
B-9
El. 98.0
3.0"
Stiff brown and gray clayey silt.
S 78 41 2.5" 11
S 82 38 2.5" 9
Soft gray and brown silty clay.
1.6 81 40 1.4" 7
S 88 30 2.5" 9
Soft gray and blue gray silt and clayey silt.
1.7 85 36 1.4" 9
Slightly compact blue green and tan silt and sandy silt.
6-17-59
B-10
El. 98.15
3.0"
Slightly compact to loose brown silty medium to very coarse sand and fine to medium gravel.
2.5" 16
0.9 112 18 1.4" 10
S 119 11 2.5" 10
S 86 37 2.5" 11
1.9 85 37 1.4" 8
Stiff and soft brown and gray inter-bedded clayey silt, silt and clayey fine sandy silt.
S 91 31 2.5" 11
G.W.S. El. 70.2 6-18-59
1.1 100 25 1.4" 7
6-18-59
B-11
El. 99.22
3.0"
Loose brown silt and sandy silt with scattered fine gravel.
S 107 19 2.5" 10/16
Slightly compact brown clayey and silty medium to very coarse sand and fine to medium gravel.
129 11 1.4" 12
S 90 33 2.5" 10
G.W.S. El. 81.3 6-18-59
2.9 112 18 1.4" 11/22
Slightly compact and compact brown clayey, sandy silt, silt and clayey silt with beds of clayey sand and gravel throughout.
S 108 22 2.5" 22
2.1 108 21 1.4" 11
Dense brown clayey sand and gravel and compact brown silt.
6-18-59

—PROFILE—

LEGEND OF EARTH MATERIALS

SIZE CLASSIFICATION

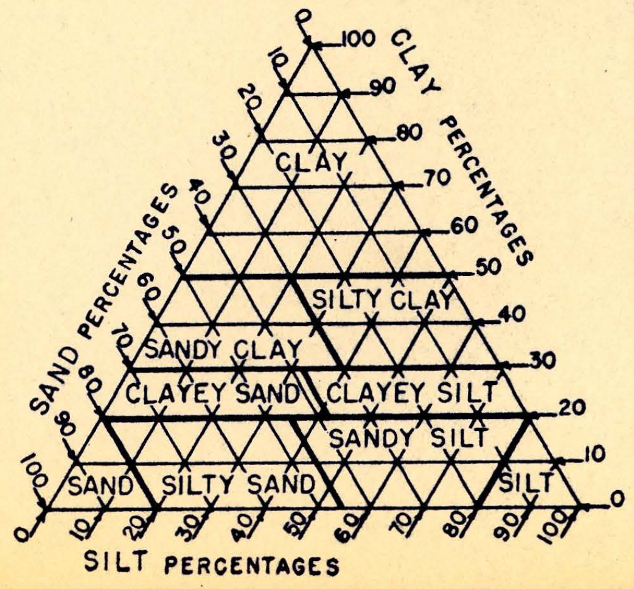


Diagram showing the basis of gransize distribution used in determination of class names. Size classification is based on the Wentworth grade scale in field classification or the A.S.T.M. grade scale in the laboratory sieve analysis.

Classification of earth material shown on this sheet is based on field inspection and should not be construed to imply mechanical analysis unless so stated.

MATERIAL SYMBOLS

▨ Gravel
▨ Sand
▨ Silt
▨ Clay
▨ Sandy clay or clayey sand
▨ Sandy silt or silty sand
▨ Silty clay or clayey silt
▨ Peat or organic matter
▨ Fill material
▨ Shale
▨ Sandstone
▨ Limestone
■ Metamorphic rock
▨ Igneous rock

CONSISTENCY CLASSIFICATION

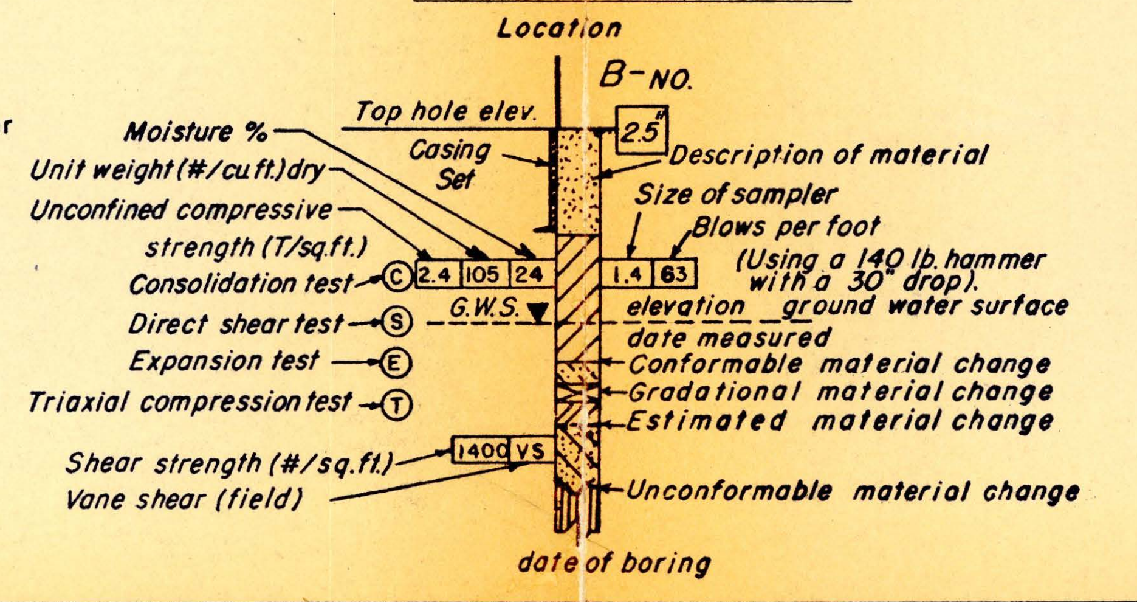
According to the Standard Penetration Test.

No. of blows	Granular	Cohesive
0-5	very loose	very soft
6-10	loose	soft
11-20	slightly compact	stiff
21-35	compact	very stiff
36-70	dense	hard
70+	very dense	very hard

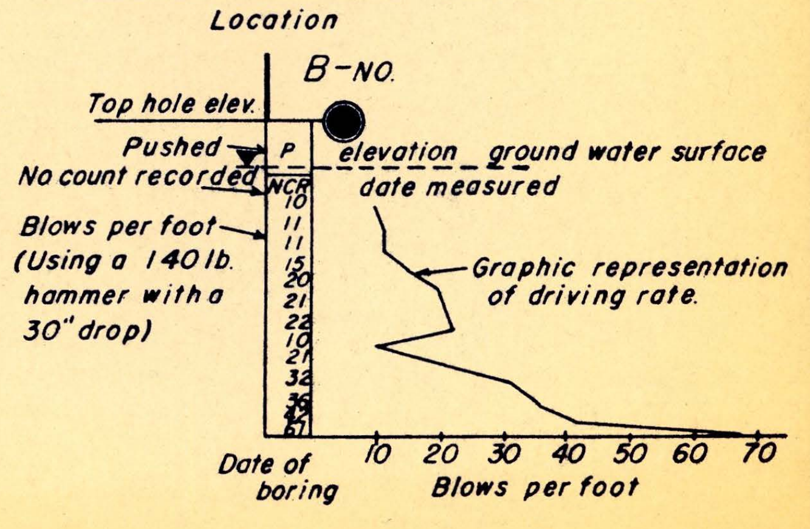
LEGEND OF BORING OPERATIONS

● Plan of any boring
Size Flush penetrometer
● 2.5" Cone penetrometer
Size Rotary boring
Size Auger boring
Size Sample boring
Size Jet boring
Size Diamond core boring
☐ Test pit

ROTARY BORING


Location
B-NO.
Top hole elev.
2.5"
Moisture %
Unit weight (#/cu.ft.) dry
Unconfined compressive strength (T/sq.ft.)
Casing Set
Description of material
Size of sampler
Blows per foot (Using a 140 lb. hammer with a 30" drop).
Consolidation test C
2.4 105 24
1.4 63
G.W.S.
elevation ground water surface date measured
Direct shear test S
Expansion test E
Triaxial compression test T
Conformable material change
Gradational material change
Estimated material change
Shear strength (#/sq.ft.)
Vane shear (field)
1400 VS
Unconformable material change
date of boring

PENETRATION TEST



MOORE and TABER
Engineers — Geologists

Job No. 3916 F-1
APPROVED H. R. Taber 7-20-59
LICENSED CIVIL ENGINEER No. 9165

SANTA CLARA COUNTY FLOOD CONTROL
AND WATER CONSERVATION DISTRICT

GUADALUPE RIVER CHANNEL

LOG OF TEST BORINGS

Scale	Date	File	Drawing

VERNLITE CLEARPRINT 1000H